

**CLOSED LOOP FEEDBACK SYSTEM
FOR IMPROVED DOWN LINK PERFORMANCE
ABSTRACT OF THE INVENTION**

A method includes receiving at least two space-time coded signals from an antenna system associated with a first station, determining complex channel state information based on the received space-time coded signals, and sending the complex channel state information to the first station. In an alternative embodiment, a method includes transmitting at least two space-time coded signals in respective beams of a multi-beam antenna array, measuring a channel impulse response for each space-time coded signal at a second station, and sending an indicia of a selected set of least attenuated signals from the second station to the first station. The multi-beam antenna array is associated with a first station. The beams transmit a signature code embedded in each respective space-time coded signal, and the signature codes are orthogonal so that the second station can separate and measure the channel impulse response corresponding to each space-time coded signal. The space-time coded signals include the selected set of least attenuated signals and a remaining set of most attenuated signals. In an alternative embodiment, a method includes selecting at least two beams of plural beams formed by a multi-beam antenna array associated with a first station for transmission of a corresponding at least two space-time coded signals produced by a space-time encoder, determining a time delay associated with each of the at least two space-time coded signals as received in each respective beam, and setting into a variable delay line the time delay corresponding to each beam, each variable delay line being coupled between the multi-beam antenna array and the space-time encoder.

x A method includes receiving at least two space-time coded signals from an antenna system associated with a base station, determining complex channel state information based on signal strengths of the received space-time coded signals, and

sending the complex channel state information to the base station. In an alternative embodiment, the method includes transmitting plural calibration signals in respective beams of a multi-beam antenna array associated with a base station, the beams transmitting plural signature codes embedded in the respective calibration signals, the plural signature codes being substantially orthogonal so that a remote station can separate and measure a channel attenuation corresponding to each of the plural calibration signals. The method further includes measuring the channel attenuation for each of the plural calibration signals at the remote station, the plural calibration signals including a selected set of least attenuated signals and a remaining set of most attenuated signals, and sending an indicia of the selected set of least attenuated signals from the remote station to the base station. In yet another embodiment, a method includes selecting at least two beams of plural beams formed by a multi-beam antenna array associated with a base station for transmission of a corresponding at least two space-time coded signals produced by a space-time encoder, the at least two beams including a reference beam and at least one remaining beam. The method further includes determining a time delay corresponding to each beam of the at least one remaining beam, and setting into a variable delay line the time delay corresponding to each beam of the at least one remaining beam, each variable delay line being coupled between the multi-beam antenna array and the space-time encoder.